NEXT-GENERATION ECOSYSTEM EXPERIMENT (NGEE ARCTIC): OPPORTUNITIES FOR INTERNATIONAL COLLABORATION AND PARTNERSHIP

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The Next-Generation Ecosystem Experiments (NGEE) project will use observations and models to quantify the response of physical, ecological, and biogeochemical processes to climatic change across molecular to landscape scales. Our approach addresses the question ***"How does permafrost thaw and degradation, and the associated changes in landscape evolution, hydrology, soil biogeochemistry and plant community dynamics, affect feedbacks to the climate system?***" Field and lab research will focus on interactions that drive ecosystem-climate feedbacks through greenhouse gas fluxes and changes in surface energy balance. These feedbacks will arise due to gradual thawing of permafrost and thickening of the seasonal active layer. Feedbacks will also occur as a result of the threshold-dominated processes of permafrost degradation and thermokarst formation and through the many processes that are influenced as a result of these landscape-scale dynamics. Our approach will consider how components of complex systems are linked and the interplay in space and time that determines system behavior. Fundamental knowledge gained in these investigations will be used to improve representation of ecosystem dynamics, subsurface biogeochemistry, and land-atmosphere processes in regional and global models, and will reduce uncertainty and improve prediction of climate change in high-latitude ecosystems.

The research scope of NGEE Phase 1 is designed to address our overarching science question through a series of integrated field observations, lab experiments, and modeling activities. Permafrost degradation and its impact on water, nitrogen, carbon, and energy-related processes will be investigated across a hierarchy of scales, including the pore/core, plot, and landscape scales. Field research will be conducted in Alaska on the North Slope (Barrow) and Seward Peninsula (Council), U.S.A. Phase 1 modeling efforts will focus on application of existing models to evaluate their predictive capability across a range of spatial scales, from single-column to plot to landscape scales. Model results will be compared with laboratory experiments and field observations at the Barrow and Council sites. We will simulate permafrost degradation in a warming Arctic using the land surface component of a major climate prediction model as well as several high-resolution process-resolving models of subsurface physical and biological dynamics. These integrated experimental and modeling efforts will (1) quantify how permafrost degradation influences surface and subsurface hydrology, (2) resolve biogeochemical mechanisms that control rates of CO_2 and CH_4 flux, (3) characterize the role of nitrogen availability in shrub expansion and plant productivity, (4) identify mechanisms underlying changes in ecosystem net energy budgets due to vegetation dynamics, and (5) quantify prediction capabilities associated with existing models.

Insights gained in Phase 1 will be used to address the challenge of extrapolating process studies to larger grid scales of climate models and to sharpen our scientific hypotheses about physical, chemical, and biological processes that shape the structure and function of Arctic ecosystems. Our goal throughout the NGEE project will be to provide the underpinning science and process understanding required to develop a new generation of high-resolution land surface simulation capabilities for the Arctic.